

CAN POSITION LIMITS RESTRAIN “ROGUE” TRADING?

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Abstract: This paper studies the imposition of position limits on commodity futures from the perspective of curbing excessive speculation and thus manipulation. We present a simple General Equilibrium model in a static Rational Expectations framework and agent heterogeneity to illustrate that excessive speculation is *foolhardy*, as it serves to enrich other agents at the expense of the speculator. Position limits, on the contrary, are not only superfluous, but also counter-productive, as they exacerbate the deterioration of the equilibrium to lower levels of pareto-efficiency with *increasing* market power. Position limits not only reduce social welfare but also *cannot* restrain market manipulation.

JEL Classification Codes: D40, D53, D58, D74, D91, G12, G13, N20

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I. INTRODUCTION

“Futures market regulation continues to be a ball game in which lawyers are carrying the ball, with economists on the sidelines.”

(Reynold P. Dahl, 1980, p. 1047)

The recent surge in commodity prices has created a global crisis, causing political and economic instability and social unrest (see Abbott, 2009). Although there are external factors contributing to the crisis, the spike in prices has naturally attracted the scrutiny of lawmakers and regulators (see U.S. Senate Subcommittee Report, 2009).¹ Particularly as this crisis comes in the wake of several excessive futures trading scandals by Steve Perkins (of PVM Oil Associates), Jérôme Kerviel (of Société Générale), Evans “Brent” Dooley (of M.F. Global Ltd.), Brian Hunter (of Amaranth Advisors LLC.), Chen Jiulin (of China Aviation Oil Corporation–Singapore), Yasuo Hamanaka (of Sumitomo Corporation), and Nick Leeson (of Barings Bank), alarming regulators across the globe. These traders, with the exception of Hamanaka, were speculating excessively but apparently without any intention of manipulating the market. Nonetheless, excessive trading (with or without the intent to manipulate the underlying spot market) impacts adversely on both the prices paid by the ultimate consumer (as observed in the cases of gas and copper prices by the acts of Hunter and Hamanaka respectively) and/or the capital base of their respective firms, and thus affects the systemic risk of the global financial system (see Krugman, 1996; Bernanke, 2006; Davis et al. 2007; Blas, 2009). In this context, Commissioner Chilton of the Commodities Futures Trading Commission (CFTC) has termed excessive trading as one of the “dark markets” and aims to curb it by imposing position limits (termed by him as “speed breakers”) or caps on the amount of futures contracts traded by participants, as given below (see Chilton, 2007).

¹ Irwin and Sanders (2010) downplay the role of speculation, while Trostle (2008) attributes several factors to the “run up” in commodity prices. These include: (i) slower growth of production and rapid growth in demand, leading to a global tightening of stockpiles of grains and oilseeds; (ii) increased demand for biofuel feed stocks; (iii) adverse weather conditions (especially in 2006 and 2007) in major grain and oilseed producing parts of the world; (iv) decline in the value of the U.S. dollar; (v) increasing cost of factors of agricultural production (including that of energy); (vi) growing foreign-exchange holdings of key food-importing countries; and (vii) structural change in policies implemented by some exporting and importing countries to mitigate their own price inflation.

Excessive Speculation is defined by the CFTC as “*an activity that causes sudden or unreasonable fluctuations or unwarranted changes in the prices of commodities*” (see Grant, 2007b). Market manipulation, on the other hand, is not defined under the Commodities Exchange Act (CEA) of 1936, and has been left to the court's jurisdiction. Kyle and Vishwanathan (2008) define it as a “strategy, which simultaneously undermines both pricing and market liquidity.” The practice is abhorred, as it perverts two basic roles of prices in financial markets, i.e., allocational efficiency (relating to market informativeness) and transactional efficiency (relating to market liquidity).

Practitioners attribute excessive speculation (especially by hedge funds) to the alteration of the dynamics of the futures markets. Sean Cota, North-east Chairman of the Petroleum Marketers Association of America, expresses his dismay in the following words: “*Speculators are important in our market, without them we would not be able to hedge futures demand for our consumers. But with hedge funds and other speculators entering the market, sometimes it seems to have the effect of an elephant jumping into the bath tub.*” (see again Grant 2007b). Excessive speculation is generally considered to be less harmful to society than market manipulation, as there is no intentional distortion of prices (see Pirrong, 1994). In this paper, we investigate whether the mechanism of position limits, which are designed to block excessive speculation, can also curtail access to the greater evil of market manipulation.

Economists, however, are quite skeptical of the value of any constraints on futures market participants, despite the good intentions of regulators to ensure efficiency and authenticity in price movements.² In fact, many eminent economists have argued that government regulation of manipulative practices in financial markets is superfluous, as exchanges themselves have incentives to take precautions against the exercise of market power

² It should be noted that we focus on the general case of trading commodity futures, where regulation is a market disruption with negative effects. We do not study the special and more intricate case of rogue trading by agents of depository institutions, where the failure of a “principal” may be of more grave consequence than that of regulation. Thus, both effects impact on the functioning of the market. In this special case, it is difficult to discern the “lesser” of the two evils. The “Volcker Rule” in the Dodd-Frank Wall Street Reform and Consumer Protection Act (signed recently into law by President Obama): (i) prohibits financial institutions from engaging in proprietary trading; and (ii) curtails their investment in hedge funds and private equity funds to 3 percent of their tier-one capital (see Government Printing Office, 2010).

(see Easterbrook, 1986; Miller, 1989; and Fischel and Ross, 1991). Both France (1986) and Pirrong (1994) doubt the alleged role of position limits in deterring market manipulation, and others, including Edwards (1984) and Pliska and Shalen (1991), blame position limits for reducing liquidity, increasing execution costs, impacting price volatility, and transferring business from exchanges to over-the-counter markets (OTC). However, this view is challenged by Pirrong (1995) who states that exchange members are likely to ignore the effects of manipulation on infra-marginal traders. Furthermore, price informativeness and competition between exchanges may be limited in practice, and indeed collective action problems preclude efficient exchange intervention. Ignoring the upcoming regulatory reform hinted at by Commissioner Chilton (where some kind of regulatory oversight is expected to be extended to the OTC derivatives market), this criticism does have some merit historically. For example, Amaranth was able to bypass the position limits imposed by the New York Mercantile Exchange (NYMEX) by moving its positions to the Intercontinental Commodity Exchange (ICE), an OTC electronic energy swaps platform (outside the jurisdiction of the CFTC, see Grant 2007a).

Despite economists' misgivings on position limits, stacking up positions in the OTC markets entails other forms of costs and risks, as realized very late by Amaranth. This is because informal forward contracting in the OTC is inefficient, as it involves excessive transaction costs. Furthermore, the lack of contract standardization and absence of institutional “marking to market” (in the OTC) aggravates the incentives to default.³ Finally, reversal of forward contract prior to maturity is cumbersome, as one is completely at the mercy of the original counterparty (see Telser, 1981).⁴

³ The mechanism of “mark to market” in standard exchanges alleviates counterparty risk. This is because it curtails the incentive to default, as it is able to flag the decline in the collateral (i.e., margin cushion below a certain threshold), allowing a broker to issue a margin call to the investor to build up his/ her cushion. If the investor does not meet this requirement, then his/ her position may be closed out. This control mechanism is absent in the OTC market, thereby aggravating the incentive to default.

⁴ The recent passage of the Dodd-Frank Financial Reform Act elevates the status of the CFTC and extends its authority beyond the futures exchanges to the OTC derivatives market. The new law mandates financial institutions to: (i) conduct their commodity derivative trades from a separate subsidiary (with a higher capital requirement); and (ii) shift them from the OTC market onto electronic exchanges or networks (see Government Printing Office, 2010). The intention behind this aspect of the legislation is to reinforce some

This paper takes a novel approach to studying manipulation in the absence of market imperfections, like information asymmetry and/or irrational players (see Kyle and Vishwanathan, 2008). This is because a framework of risk aversion under symmetric information (i.e., rational expectations) can yield results similar to that of information asymmetry. This is attributed to the inducement of differential hedging (i.e., consumption smoothing) costs stemming from heterogeneity of wealth of agents in the economy, as originally espoused in Arrow (1970). Consider for example, an experimental economic setting under risk aversion and symmetric information. In this environment, a sudden reduction in wealth for some agents in the economy makes them perceive the risky project undertaken before as more risky, in accordance with Rabin (2000). This leads the impacted agents to bid less or none at all, for a risky asset. This in return leads to a reduction in liquidity of the risky asset, thus conveying a negative “signal” to an outsider who may not be aware of the experimental setting. Another insight of this study stems from the recent spike in commodity prices, attributed to manipulation by financially astute speculators. This has led to a public outcry amongst the allegation that wealth endows economic agents with means of influencing futures prices and extricating economic surplus (see again Grant, 2007b; and U.S. Senate Subcommittee Report, 2009). Thus, the purpose of this paper is: (i) to investigate whether wealth endows rogue traders the ability to manipulate it, thus extricating economic surplus; and (ii) to study the impact of imposition of position limits as a means of curtailing excessive speculation and thus market manipulation by savvy investors.⁵

“skin in the game” (i.e., equity cushion) and transparency. This restraint in the law is added to avoid a situation similar to that of the American International Group (AIG), which was able to accumulate its credit exposure virtually unnoticed, leading to its near collapse and subsequent bailout by the federal government (see Boyd, 2011).

⁵ The pricing of futures serves as an insurance mechanism to transfer price risk to speculators. This issue has intrigued both academics and practitioners. The seminal work of Keynes (1930), however, does not strictly distinguish between discount and premium (of futures prices), and refers to both of them as Normal Backwardation. However, contemporary literature distinguishes both, and classifies Normal Backwardation and Contango as situations where futures trade below and above expected spot price, respectively.

We model commodity futures in a simple general equilibrium setting, augmented within a framework of rational expectations.^{6, 7} We initially assume a simple economy of three types of agents composed of Hedgers (both Commodity Producers and Consumers) and Speculators. We also incorporate competition between the hedgers and speculators, and superimpose binding real sector (i.e., capacity) constraints and financial sector constraint (i.e., connecting the aggregate supply and demand of futures), as described below. We then investigate the model solution by extending it to include storage operators. Our model can be perceived as “trade-based manipulation” in accordance with the nomenclature of Kyle and Vishwanathan (2008), as it involves trading only without any “off-the-street financing” and false disclosures.

We reduce the endemic moral hazard in the financial sector by allowing agents to only enter into contracts they can easily fulfill.⁸ This necessitates limited futures contracting and is supported by both academics as well as practitioners (see Rolfo, 1980; and Lee, 2003). This condition is in the spirit of that imposed in the pioneering work of Gustafson (1958), which reinforces the impossibility of carrying forward negative inventories by a storage operator. We thus confine the commodity producers (as short hedgers) to shorting the amount of futures they

⁶ We opt for a setting involving symmetric information, as equilibrium asset prices aggregate and reveal private information (see Biasis et al., 2010). Thus, capital market participants can easily decipher any private information held by any counterparty by observing their trading patterns. This result is a consequence of the Efficient Market Hypothesis (EMH – see Fama, 1970; Bray, 1981; Malkiel, 2003). This has credence in the real world as (i) George Soros could see through Hamanaka’s copper market manipulation (but gave up too soon, as he was intimidated by Sumitomo’s seemingly limitless financial resources – see Krugman, 1996); and (ii) Amaranth’s competitors had realized its vulnerabilities in the gas futures market and apparently traded against its positions (see Davis et al. 2007).

⁷ Maddock and Carter (1982) define rational expectations as “*the application of the principle of rational behavior to the acquisition and processing of information and to the formation of expectations.*” Bray (1981) explicates it further by classifying rational expectations equilibrium as “*self-fulfilling*”, as economic agents form correct expectations, given the pricing model and information.

⁸ Moral hazard arises when economic agents maximize their own welfare to the detriment of others, especially in situations where they do not bear the full consequences of their actions. They therefore have a tendency to act less carefully than they otherwise would, leaving another party to bear some responsibility for the consequences of those actions (see Kotowitz, 2008). Moral hazard is generally considered in the literature as ensuing from information asymmetry. However, it can even wreak havoc in capital markets where asset pricing aggregate and reveal private information. In the context of our study, one group of agents (called unerring ones) generally bears the brunt of any excessive futures contracting beyond the means of the erring ones. We therefore impose constraints on the various groups of agents, which deter any excessive futures contracting. In the “real” world, this needs to be incorporated by strengthening the internal risk management system of firms involved in futures trading. This is elaborated in our Concluding Section.

are able to produce in the worst state of the economy. Likewise, the consumers (as long hedgers) are constrained to enter into futures contract to the extent of the minimum value of their exogenous demand function in the worst state of the economy. Finally, the speculators are also restrained by the aggregate demand-supply condition in the futures market. This constraint reduces the risk of a well-known form of market manipulation called the “corner” or “squeeze” based on the terminology of Irwin and Sanders (2010).⁹ This is because a speculator in our framework cannot buy more futures contract than commodities to be delivered in the spot market. This does not compel those who have sold to the speculator and cannot deliver in the spot market, to buy back their contracts at an excessive price.

Regulations inhibiting the freedom to contract of speculators alone (in the form of position limits) will yet hinder the freedom to contract of all market participants. This is because of the aggregating condition linking supply and demand within futures markets. Ignoring binding constraints on futures market participants can lead to erroneous futures pricing conditions.¹⁰

Our complete market model is in the spirit of Anderson and Danthine (1983) and Britto (1984), where random shocks of production (or yield risk), emanating from the supply side, impact on the equilibrium pricing of the commodity on the demand side, leading to price risk. This has credence in the real world, as agricultural commodities are subject to the fluctuations of weather on the supply side, giving rise to changes in prices on the demand side.

⁹ We find variance in the classification of the forms of manipulation in the literature. For instance, our simple model (of Sections III and IV – without storage) is construed as a “corner” or “squeeze” by Irwin and Sanders (2008). In contrast, the extended model (of Sections V – with storage) is perceived in Kyle and Vishwanathan (2008) strictly as a “corner” or “squeeze” under a buildup of inventories and a “reverse corner” or “reverse squeeze” under depletion of inventories.

¹⁰ It should be noted that, in the “real world,” corporate derivative usage for commodity companies is contingent on the method of compensation of its managers. If managers possess a substantial part of their personal wealth through company’s shares or if their compensation is tied to the accounting measure of earnings, then they will try to avoid risk (of variability of their wealth or income) by hedging. However, if managers are compensated by out-of money stock options, whose strike price is much higher than the current stock price, then there is an incentive for the managers to increase the risk of the firm by not hedging its cash flow (see Smith and Stulz, 1985; Tufano, 1996; and Haushalter, 2000). To keep our model simple and tractable, we purposely avoid the intricacy of manger compensation in our study.

We chose the general equilibrium (GE) modeling for its rigor and strong following in the academic and policy communities (see Zame, 2007). It also has the advantage of allowing participants to stack up on open interests on futures (subject to their binding constraints). Within this model, use of Rational Expectations is consistent with the well-known Efficient Market Hypothesis (EMH – see Fama, 1970; Bray, 1981; and Malkiel, 2003). Incorporating competition between economic agents helps evaluate the supply and demand side relationships and consequently the equilibrium parameters of a futures contract. Our approach is at variance with the pedagogically convenient Partial Equilibrium (PE) models, stemming from the Marshallian supply and demand framework (also termed as the Marshallian Cross), which employ either (i) Capital Asset Pricing Model (CAPM – see Breeden, 1980; Jagannathan, 1985; and Pliska and Shalen, 1991); or (ii) Hedging-Pressure Hypothesis (see Keynes, 1930; Hicks, 1939; Hirshleifer, 1988; and De Roon et al., 2000). This is because traditional PE models assume that competition is perfect in the sense that no agent possesses market power. This approach, however, fails to incorporate concentration of open positions in only a few hands and so cannot accurately model real world situations.

Our model is distinct from these traditional models for several reasons. Firstly the various “representative” agents in our economy depict average behavior for that class of agents. That is, producers in our model are strictly short hedgers, while consumers are strictly long hedgers. This reflects on the aggregate behavior of constrained agents and is in contrast to that of the unconstrained agents in the traditional models. Secondly, the single period nature of our model further restricts the various classes of agents able to enter into binding contracts, which cannot be offset with the revelation of more information, as in a multi-period PE environment. Finally, our model prices futures in a nonlinear framework instead of a linear, i.e., “cash and carry” one, where arbitrage is not feasible (see Varian, 1987). In other words, our approach yields pricing functions of futures in terms of the risk aversion parameters of agents in the economy.

To the best of our knowledge, this paper is among only a few analytical papers investigating the issue of position limits. An earlier paper by Pliska and Shalen (P&S, 1991)

examined this issue (in a partial equilibrium setting) by only optimizing the welfare of the speculator in a mean-variance framework using numerical simulation. In their stylized model, speculators are constrained by position limits but hedgers are not. P&S realize a unique equilibrium where an increase in position limits increases volatility, as it decreases the ability to offset exogenous hedging demand. Thus, position limits decrease the volume of trade, i.e. liquidity and appear destabilizing. P&S also ascertain that if speculative limits are extremely restrictive, then hedging demand cannot be accommodated. In other words, equilibrium is infeasible under restrictive position limits.

In contrast to P&S, our static general equilibrium model illustrates the following. First, an economy unconstrained by regulators yields a multitude of equilibria ranked in a pecking order of decreasing pareto-efficiency ranging from the most efficient interior equilibrium (where the internal financial sector constraints, inhibiting the ability of errant agents to endanger the remaining, are not binding) to the least efficient corner ones (where one or more internal constraints are strictly binding). The most efficient equilibrium is devoid of any market power, while the less efficient ones convey market power to one or more agent(s) in the economy.

Second, excessive speculation by a wealthy speculator is imprudent, akin to a winner's curse, as it serves to enrich other agents in the economy. The novelty of this result stems from our framework of symmetric information instead of the usual asymmetric cases. Thaler (1988, p. 192) highlights this issue as follows: "*The winner's curse cannot occur if all bidders are rational...so evidence of a winner's curse in market settings would constitute an anomaly.*" Our contrary result, however, stems from decreasing absolute risk aversion, as observed experimentally by Schechter (2007) and Guiso and Paiella (2008). They also augment the results of Milgrom and Stokey (1982) and Tirole (1982), construed in a PE framework, to the special case of affluent investors with the prowess to impact on futures prices.¹¹

¹¹ There are subtle differences between our framework and that of Milgrom and Stokey (1982) and Tirole (1982). Our model integrates the real sector with the financial one in a GE setup, while the remaining two papers study speculation from the perspective of the financial sector only. Furthermore, our results entail multiple equilibria, while those of the other two depict a unique one.

Third, restrictive position limits imposed on speculators, however, are superfluous, as the economy already has an embedded check and balance system in the form of internal financial sector constraints, alleviating the endemic moral hazard of the economic system. Binding position limits also inhibit the freedom of hedgers, thereby reducing the overall endogenous hedging demand and volume of trade (i.e., liquidity). This not only reduces social welfare of agents but also steers the equilibria to more degenerative corner ones where the market power of speculators and/ or other agents are enhanced. Position limits are therefore backfiring, as they augment market power of speculators (along with other agents) instead of diminishing it. In a further divergence with P&S described above, we observe two equilibria where position limits are so restrictive that they completely inhibit all speculative activity. Yet, they convey economic power to either Consumers or Producers. Our result in this special case is even contrary to the prognosis of Keynes (1930).

Finally, our analysis reveals that GE models, though intricate, provide a richer and deeper understanding compared to the widely used PE models in the literature.

This paper is organized as follows: Section II elaborates more on Position Limits; Section III illustrates the theoretical underpinnings of our simple model with producers, consumers and speculators; Section IV explicates the simple model solution (relegating the proof of our theorem to the appendix); Section V extends the simple model to include storage operators; Finally, Section VI provides some concluding remarks.

II. POSITION LIMITS

Speculative Position Limits are defined as the maximum number of contracts entered into by a non-hedger. The rationale behind the imposition of these limits is to prevent speculators from gaining power to exert undue influence on the market, thereby ensuring efficiency and authenticity in price movements. Regulators may also use “circuit breakers” such as daily price limits (in the form of upper and lower bounds on price movements) to arrest extreme volatility and pre-empt market manipulation (Brennan, 1986; and Kodres and O’Brien,

1994).¹² In contrast to position limits, price limits may be disruptive, delay the price discovery process, and may not deter a prospective manipulator from gaining access to a large position which endows him/ her with market power (Kim and Yang, 2004). Position limits are generally construed as a proactive mechanism of curbing market manipulation, while price limits are considered a reactive mechanism.

Position limits are segregated into speculative position limits and hedging exemptions. That is, speculators are strictly subject to these limits, while hedgers are exempt as long as they can demonstrate that the large positions are essential for implementing a bona fide hedge. It should be noted that this does not imply that hedgers are free from restraint. They are still subject to their real sector constraints, contingent on their operational capacity. For example, they cannot enter into contracts in excess of what they can deliver (for a producer) or what they normally consume (for an intermediate-user or end-user). The exchanges can still deny or revoke hedging exemptions if they suspect the position to be speculative instead of the claimed hedging.

The exchanges set the standards for establishing position limits in an ad hoc manner, using factors related to the underlying commodity. For instance, in the case of gold, the exchange determines the total volume taking into account the size of the spot market. Based on this figure and the number of estimated traders, the exchange sets the fraction of the total market which each broker can hold at a broker level (or member level), and a separate fraction that can be held at an individual level. Violating these limits could result in disciplinary action by the exchange.

In markets, where physical delivery of the commodity is involved, speculative limits are set at a lower level in the month when the contract matures. This is because (in the spot month) the contract is vulnerable to price swings caused by large positions and other manipulative practices. Thus, spot month limits are generally set lower, around 5 percent of

¹² Please note that we do not compare position limits with other “circuit breakers” such as trading halts, as they are predominately used in the stock markets and not in the futures markets.

deliverable supply. To mitigate the risk of price manipulation further, the exchanges also levy delivery margins to discourage the holding of large positions in the delivery month.

In implementing these speculative limits, the exchanges impose the aggregation rule to arrest price swings in spot months in conjunction with far months. Exchanges aggregate all the futures positions owned or controlled by one trader (or a group of traders acting in concert). This principle is also implemented at the individual clearing member level, where accounts are aggregated under the same ownership. With the upcoming regulatory reform, it is anticipated that this aggregation rule will not only be applied to national exchanges and over the counter markets (OTCs), but that there will also be much more cross-border coordination with overseas regulators to implement it across the globe (see CFTC, 2010).¹³ The basis for the increased oversight is to mitigate systemic risk in a globally integrated economy (see Colacito and Croce, 2010; and Stiglitz, 2010)

Table 1 illustrates position limits and reportable levels for commodity futures traded on the Chicago Board of Trade (CBOT), as this is the focus of this paper. For the sake of simplicity, we ignore equivalent options contracts on the underlying futures contracts.

[TABLE 1 HERE]

¹³ The CFTC has proposed imposing of federal limits on traders' positions in the U.S. energy futures markets, where the caps are currently delegated to exchanges. In selected agricultural products, it already controls limits and grants exemptions from them. The agency is also planning to extend the federal limits to metals such as copper, gold and silver. The all-month speculative limits are to be set on aggregated contracts held on all CFTC regulated exchanges. This is fixed on a formula based on open interest, or the number of outstanding contracts. The all-months combined position limits would be set to 10 percent of the first 25,000 contracts of open interest, and 2.5 percent of open interest beyond 25,000 contracts. For single month, the new limits would be set at two-thirds of this total. The proposed limits maintain exemption for entities, such as airlines and oil companies, which employ futures contracts to hedge "commercial" risks. This is however rescinded for hedge funds and other financial traders classified as "non-commercial". These entities would have to migrate to a new "limited" exemption provided to swap dealers (see again CFTC 2010).

III. MODEL DEVELOPMENT OF A SIMPLE ECONOMY

For simplicity and mathematical tractability, we assume a one-period economy with two goods and three types of agents.¹⁴ There are n_p identical Producers (**P**), n_c identical Consumers (**C**) and n_s identical Speculators (**S**), each endowed respectively with e_p , e_c and e_s units of the numeraire good in our economy.¹⁵ Good ψ is a perishable good produced solely for the Consumers by the Producers.¹⁶ The Producers and Consumers constitute hedgers in our setting. The production process used for Good ψ is subject to random shocks ($\tilde{\xi}$) stemming from exogenous forces such as weather or any idiosyncrasy of the production process. The distribution of $\tilde{\xi}$ is known to all agents. Each producer converts x units of numeraire good into \tilde{y} units of Good ψ using the production function $g(x, \tilde{\xi})$, where $\tilde{y} = g(x, \tilde{\xi})$. Furthermore, $g(0, \tilde{\xi}) = 0$, $\frac{\delta g}{\delta x} = g_1 > 0$, $\frac{\delta g}{\delta \xi} = g_2 > 0$, and $\frac{\delta^2 g}{\delta x^2} = g_{11} < 0$. The decision on the amount (x) of input to be used for the production of Good ψ is made in the beginning of the period, while the output of the production process is available at the end of the period. Futures contracting is initiated at the beginning of the period, while its settlement takes place at the end.^{17, 18} The demand for Good ψ is termed as $D(\tilde{p}, e_c)$, where \tilde{p} is its stochastic price in the

¹⁴ We model the futures market in the framework of Britto (1984), where the role of government (especially with respect to subsidies on commodities) is assumed away. This is because government incentives (in the form of put option on futures prices) merely redistribute the tax burden on other sectors of the economy (see Bankman, 2004).

¹⁵ In the current regulatory environment, Producers, Consumers and Storage Operators (discussed in Section V) are classified as “commercials”; while Speculators, who take positions based on price movements, are classified as “non-commercials”. Hedge funds, Futures-based commodity Exchange Traded Products (ETPs) and Commodity-Trading Advisors (CTAs) constitute the category of Speculators.

¹⁶ The assumption of perishability of Good ψ is not crucial to our analysis. It is relaxed in Section V to illustrate the invariance of the quality of our results.

¹⁷ It should be noted that our one period model resembles that of a forward contract. This is because differences between futures and forward prices for short-term contracts with settlement dates less than nine months tend to be very small. That is, the daily marking to market process appears to have little effect on the setting of futures and forward prices. Moreover, if the underlying asset’s returns are not highly correlated with interest rate changes, then the marking to market effects are small even for longer-term futures. Only for longer-term futures contracts on interest-sensitive assets will the marking to market costs be significant. Because of this, it is a common practice in the literature to analyze futures contracts as if they were forwards. For details see Hull (2006).

¹⁸ For the sake of simplicity, we ignore the institution of margin, as our single period setting does not necessitate marking to market.

spot market, while e_c is the income (endowment) of the consumer. Since this demand stems only from the consumers all that is produced is purchased for consumption at the end of the period. Good ψ is defined by the sign of the covariance between the two risks emanating from the optimal production yield (\tilde{y}^*) and the spot price (\tilde{p}) (Hirshleifer, 1975). If the sign of this covariance is positive [negative], it is construed as normal [inferior], otherwise it is considered to be an intermediate commodity (Rolfo, 1980; Anderson and Danthine, 1983; and Britto, 1984). All agents are risk averse and maximize their respective (strictly concave and twice continuously differentiable (Von Neumann-Morgenstern)) utility functions denoted by $U_p(\cdot)$, $U_c(\cdot)$, $U_s(\cdot)$.

III.a. The Commodity Producer (P):

The goal of each of the n_p Producers is to optimally select the amount (x) of endowment to be used in the production process and the amount (q_p) of Good ψ to be pre-sold in the futures market (at a unit price f) in order to maximize their expected indirect utility of consumption. That is,

$$\begin{aligned} \text{Max. } E_0 \{U_p(\tilde{c}_p)\} \\ (\text{in } c_p, x, q_p) \end{aligned}$$

subject to the budget constraint

$$\tilde{c}_p = e_p + [\tilde{p}(\tilde{y}) - x] + q_p(f - \tilde{p}) = (e_p - x) + q_p(f) + \tilde{p}[g(x, \tilde{\xi}) - q_p] \quad (1)$$

where $E_0\{\cdot\}$ is the expectation operator at time 0, \tilde{c}_p is the consumption of Producer at $t = 1$, while the remaining notations have the same meaning as stated earlier.

The budget constraint at $t = 1$ (Equation 1) illustrates consumption of Producer utilizing the residual of endowment (net of input to the production process, i.e., $(e_p - x)$) along with the proceeds of selling Good ψ (in terms of the numeraire good) via: (i) Futures Market (involving q_p units at a fixed price f) and (ii) Spot Market (involving residual units of output, i.e., $(\tilde{y} - q_p)$ at the prevailing stochastic price \tilde{p}).

The objective function of each of the Producers can be rewritten as:

$$\begin{aligned} \text{Max. } E_0 \{U_p[(e_p - x) + \tilde{p}[g(x, \tilde{\xi}) - q_p] + q_p(f)]\} \\ (\text{in } x, q_p) \end{aligned}$$

The First Order Necessary Conditions (FONCs or Euler Equations) are evaluated as follows:

- (i) At the margin, the Producer will use an optimal amount x^* of Good 1, which yields net benefit at least equal to zero. This results in the optimal yield (production level) $\tilde{y}^* = g^*(x^*, \tilde{\xi})$ given as follows:

$$\begin{aligned} & \frac{E_0 [(U_P'(\tilde{c}_p)) [\tilde{p} (g^*(x^*, \tilde{\xi}))]]}{E_0(U_P'(\tilde{c}_p))} - 1 \geq 0, \quad \forall x^* \in (0, e_p] \\ \Rightarrow & \left\{ \frac{E_0(U_P'(\tilde{c}_p)) E_0(\tilde{p} (g^*(x^*, \tilde{\xi}))) + \text{Cov}_0(U_P'(\tilde{c}_p), \tilde{p} (g^*(x^*, \tilde{\xi})))}{E_0(U_P'(\tilde{c}_p))} \right\} - 1 \geq 0 \\ \Rightarrow & E_0(\tilde{p}(\tilde{y}^*)) + \frac{\text{Cov}_0(U_P'(\tilde{c}_p), \tilde{p}(\tilde{y}^*))}{E_0(U_P'(\tilde{c}_p))} \geq 1, \quad \forall x^* \in (0, e_p] \end{aligned} \quad (2)^{19}$$

The above equation is satisfied with the equality sign when $x^* \in (0, e_p)$ and the inequality sign when $x^* = e_p$. The inequality sign basically reflects the non-satiation point of the Producer. This implies that for an optimum y^* the corresponding input $x^* \in (0, e_p]$.

- (ii) At the margin, the Producer will sell optimally forward q_p units of Good ψ , which yield net benefits at least equal to zero. This implies that the Producer will participate in the futures market only when the optimal price of futures (f) is evaluated as follows:

$$\begin{aligned} f \geq \left\{ \frac{E_0(U_P'(\tilde{c}_p) \tilde{p})}{E_0(U_P'(\tilde{c}_p))} \right\} &= \left\{ \frac{E_0(U_P'(\tilde{c}_p)) E_0(\tilde{p}) + \text{Cov}_0(U_P'(\tilde{c}_p), \tilde{p})}{E_0(U_P'(\tilde{c}_p))} \right\} \\ &= E_0(\tilde{p}) + \frac{\text{Cov}_0(U_P'(\tilde{c}_p), \tilde{p})}{E_0(U_P'(\tilde{c}_p))}, \quad \forall q_p > 0 \end{aligned} \quad (3)$$

The above equation represents the *supply* side relationship of q_p units of output pre-sold (at a price) f , where the equality [strict inequality] sign is applicable when the amount of futures pre-sold by Producer is in the satiation [non-satiation] region. That is, in the interior [extreme right hand side] of the semi-closed interval described by our financial sector constraint alleviating moral hazard (i.e. Equation 10 in Section III.d. below). The strict equality sign of Equation (3) (and that of Equations (5) and (7) in the following subsections) imply that the futures market is not monopolistic, as none of the groups of agents have the market power to extract any economic surplus from the others. The strict

¹⁹ The algebraic simplification of the above expression exploits the well known property of ‘expectation of product of two random variables equals the product of their expectations in addition to the covariance between them’ (see Mood, Graybill and Boes, 1974).

inequality sign, however, illustrates the power of producer to wrest economic surplus from the other agent(s) in the economy.

Thus, a unique and constrained maximum of the Producer's objective function requires that the following conditions are satisfied: firstly, the stochastic budget constraint (at $t = 1$), as depicted by Equation (1); and secondly, the simplified FONCs (Euler Equations) as represented by Equations (2) and (3). We note that the second order conditions for a maximum are automatically satisfied, as Chiang (1984) demonstrates that maximization of a strictly concave and twice continuously differentiable objective function (such as a Von Neumann-Morgenstern utility function) with quasi-convex constraints yields a negative definite bordered Hessian matrix

III.b. The Consumer (C):

The goal of each of the n_c Consumers is to optimally select the amount (q_c) of Good ψ to pre-purchase in the futures market in order to maximize their expected utility of consumption. That is,

$$\begin{aligned} & \text{Max. } E_0\{U_c(\tilde{c}_c)\} \\ & \quad (\text{in } c_c, q_c) \end{aligned}$$

subject to the budget constraint

$$\tilde{c}_c = e_c - (D(\tilde{p}, e_c))(\tilde{p}) + q_c(\tilde{p} - f) = e_c - f(q_c) - \tilde{p}[D(\tilde{p}, e_c) - q_c] \quad (4)$$

where \tilde{c}_c is the consumption of Consumer at $t = 1$, while the remaining notations have the same meaning as stated earlier.

The budget constraint at $t = 1$ (Equation 4) illustrates consumption of Consumer utilizing endowment (e_c) to pay for Good ψ purchased via: (i) Futures Market (involving q_c units at a fixed price of f) and (ii) Spot Market (involving residual demand units of $[D(\tilde{p}, e_c) - q_c]$ at the stochastic spot price \tilde{p}).

The objective function of each of the Consumers can be rewritten as:

$$\begin{aligned} & \text{Max. } E_0\{U_c[e_c - (D(\tilde{p}, e_c))(\tilde{p}) + q_c(\tilde{p} - f)]\} \\ & \quad (\text{in } q_c) \end{aligned}$$

The FONC (Euler Equation) is evaluated as follows:

At the margin, the Consumer will optimally pre-purchase q_c units of Good ψ , which yield net benefits at least equal to zero. This implies that the consumer will participate in the futures market only when the optimal price of futures (f) is evaluated as follows:

$$f \leq \left\{ \frac{E_0(U_c'(\tilde{c}_c) \tilde{p})}{E_0(U_c'(\tilde{c}_c))} \right\} = E_0(\tilde{p}) + \frac{\text{Cov}_0(U_c'(\tilde{c}_c), \tilde{p})}{E_0(U_c'(\tilde{c}_c))}, \forall q_c > 0 \quad (5)$$

The above equation represents the *demand* side relationship for q_c units of output pre-purchased at a price f , where the equality [strict inequality] sign is applicable when the amount of futures pre-purchased by Consumer is in the satiation [non-satiation] region. That is, in the interior [extreme right hand side] of the semi-closed interval described by our financial sector constraint reducing moral hazard (i.e., Equation 9 in Section III.d. below). The equality sign again illustrates the absence of market power, while the strict inequality sign demonstrates the ability of consumer to extract economic surplus.

Here too, a unique and constrained maximum of the Consumer's objective function requires that the following conditions are satisfied: firstly, the stochastic budget constraint (at $t = 1$), as depicted by Equation (4); and secondly, the simplified FONC (Euler Equation) as represented by Equation (5). The second order conditions for a maximum are automatically satisfied due to the properties of a strictly concave and twice continuously differentiable utility function with quasi-convex constraints (see Chiang, 1984)

III.c. The Speculator (S):

The goal of each of the n_s Speculators is to optimally select the amount (q_s) of Good ψ to pre-purchase in the futures market, in order to maximize their expected indirect utility of consumption. That is,

$$\begin{aligned} & \text{Max. } E_0\{U_s(\tilde{c}_s)\} \\ & \text{(in } c_s, q_s) \end{aligned}$$

subject to the budget constraint

$$\tilde{c}_s = e_s + q_s (\tilde{p} - f) \quad (6)$$

where \tilde{c}_s is the consumption of Speculator at $t = 1$, while the remaining notations have the same meaning as stated earlier.

The budget constraint at $t = 1$ (Equation 6) illustrates consumption of Speculator utilizing endowment (e_s) along with net-payoffs in the futures market in Good Ψ (involving q_s units at the stochastic profit margin of $(\tilde{p} - f)$).

The objective function of each of the Speculators can be rewritten as:

$$\begin{aligned} \text{Max. } E_0\{ U_s[e_s + q_s(\tilde{p} - f)] \} \\ (\text{in } q_s) \end{aligned}$$

The FONC (Euler Equation) is evaluated as follows:

At the margin, the Speculator will optimally pre-purchase [pre-sell] q_s units of the commodity, which yield net benefits at least [at most] equal to zero. This again implies that the Speculator will participate in the futures market only when the optimal price of futures f is evaluated as follows:

$$\begin{aligned} f \leq \left\{ \frac{E_0(U_s'(\tilde{c}_s) \tilde{p})}{E_0(U_s'(\tilde{c}_s))} \right\} &= E_0(\tilde{p}) + \frac{\text{Cov}_0(U_s'(\tilde{c}_s), \tilde{p})}{E_0(U_s'(\tilde{c}_s))}, \forall q_s > 0 \\ f \geq \left\{ \frac{E_0(U_s'(\tilde{c}_s) \tilde{p})}{E_0(U_s'(\tilde{c}_s))} \right\} &= E_0(\tilde{p}) + \frac{\text{Cov}_0(U_s'(\tilde{c}_s), \tilde{p})}{E_0(U_s'(\tilde{c}_s))}, \forall q_s < 0 \end{aligned} \quad (7)$$

The above equation represents the *demand* [*supply*] side relationship for positive [negative] units of output (q_s) pre-purchased [pre-sold] at a price f , where the equality sign is normally observed in the absence of any external constraint (such as position limit) on the Speculator, while the strict inequality sign is observed only under any binding regulatory constraint. The equality sign again represents the lack of market power. In contrast, the inequality sign depicts the ability of the speculator to outbid other agents and extricate economic surplus. This illustrates that position limits are counter-productive as they endow market power to the Speculator instead of diminishing it.

As before, a unique and constrained maximum of the Speculator's objective function requires that the following conditions are satisfied: firstly, the stochastic budget constraint (at $t = 1$), as depicted by Equation (6); and secondly, the simplified FONC (Euler Equation) as represented by Equation (7). The second order conditions for a maximum are automatically satisfied due to the properties of a strictly concave and twice continuously differentiable utility function with quasi-convex constraints (see Chiang, 1984)

III.d. The Binding Constraints on Agents in our Simple Economy:

- (i) For the real sector of the economy to be in equilibrium, the aggregate demand must equal the optimal aggregate supply:

$$\begin{aligned} \text{That is, } n_c [D(\tilde{p}, e_c)] &= n_p [g^*(x^*, \tilde{\xi})] = n_p [y^*] \\ \Rightarrow D(\tilde{p}, e_c) &= \frac{n_p}{n_c} [g^*(x^*, \tilde{\xi})] = \frac{n_p}{n_c} [y^*] \end{aligned} \quad (8)$$

The above equation endogenously yields the stochastic pricing distribution of Good ψ , i.e., \tilde{p} from the distribution of the random shock $\tilde{\xi}$. This condition is equivalent to the information on the covariance between the stochastic variables, \tilde{p} and y^* . That is, on the classification of Good ψ as a Normal, Intermediate or Inferior commodity.

- (ii) In a Stationary Rational Expectations Equilibrium (SREE), Consumers commit themselves to the minimum value of their exogenous demand function in the worst state of the economy, i.e., $\text{Min.}[D(\tilde{p}, e_c)] = \frac{n_p}{n_c} \{\text{Min.}[y^*]\}$, using Equation (8).

$$\begin{aligned} \Rightarrow \frac{n_p}{n_c} \{\text{Min}[y^*]\} &\geq q_c > 0 \\ \Rightarrow q_c &\in (0, \frac{n_p}{n_c} \{\text{Min}[y^*]\}) \end{aligned} \quad (9)$$

The above equation implies that the freedom to contract futures for consumers is restricted to a range of values.

Likewise, Producers refrain from entering into futures obligations (q_p) more than what they can deliver in the worst state of the economy, i.e., $\{\text{Min.}[y^*]\}$.

$$\begin{aligned} \Rightarrow \{\text{Min}[y^*]\} &\geq q_p > 0 \\ \Rightarrow q_p &\in (0, \text{Min}[y^*]) \end{aligned} \quad (10)$$

Here too, the above equation implies that the freedom to contract futures is restricted to a range of values.

Since unerring hedgers generally bear the brunt of any excessive futures contracting by the erring ones, they can (in the context of our rational expectations setting) strictly enforce futures contracting with integrity, by refusing to enter into any offsetting futures position if the upper bounds of Equations (9) or (10) are violated. This refusal may seriously impact the reputational capital of erring hedgers (see MacLeod, 2007).

The above two constraints (Equations (9) and (10) basically curtail the endemic moral hazard in our economic system by limiting the employment of futures contracted. This

restraint is similar in spirit to the one imposed in Gustafson (1958), which espoused the impossibility of carrying forward negative inventory by a storage operator. This ensues from the fact that commodities cannot be consumed before they are produced. Similarly, Consumers and Producers cannot enter into futures contracts, which they cannot honor in a Rational Expectations economy. This presumption is supported by both academics as well as practitioners (see again Rolfo, 1980; and Lee, 2003).

The above outcome has profound implications in the internal risk management level of firms involved in futures trading. This is because the well-known Corrigan Report attributes weakness in compliance systems as a major factor provoking “rogue” trading (see Counterparty Risk Management Policy Group III, 2008). This issue is discussed further in the conclusion as the only practical solution deterring “rogue” trading.

(iii) For the financial sector of the economy to be in equilibrium:

Futures contracts negotiated by the suppliers (Producers) must equal that demanded by Consumers and Speculators.

$$\begin{aligned} \text{That is, } n_p q_p &= n_c q_c + n_s q_s \\ \Rightarrow q_s &= \left[\frac{(n_p q_p - n_c q_c)}{n_s} \right] \end{aligned} \quad (11)$$

The above equation defines the relationship of q_s in terms of q_p and q_c , which themselves are constrained as illustrated in Equations (9) and (10) respectively. It should be noted that any ad hoc restraint imposed only on the Speculators in the form of position limits will impact on both the Producers and Consumers through the aggregate demand-supply condition on futures (i.e., via Equation (11)) and contractual capacity of these hedgers (i.e., via Equations (10) and (9)). In other words, restrictions on Speculators to contract below their natural contacting level of q_s (given by Equation (11)): (i) reduces the ability of Producer and/or the Consumer to below their operational capacities (given by $\text{Min}[\tilde{y}^*]$ and $\frac{n_p}{n_c} \{ \text{Min}[\tilde{y}^*] \}$ respectively); and (ii) simultaneously leads the Speculator (and/ or one or more agent(s) to reach a non-satiation limit where their market power is enhanced. Thus, the imposition of position limits is counter-productive as it reduces the social welfare of all agents (as explicated further in the following Section); reduces the endogenous hedging demand, decreasing the overall volume of futures contracting and

subsequently the liquidity of these contracts, while enhancing the market power of Speculators in addition to one or more agent(s) in the economy.

IV. MODEL SOLUTIONS

A Stationary Rational Expectations Equilibrium (SREE), in the context of our study, is defined as one where all agents in the economy are aware of both the values of the random shock of the production process ($\tilde{\xi}$) along with its probability distribution, and the demand function of the consumers for the Good ψ , i.e., $[D(\tilde{p}, e_c)]$. They are also capable of endogenously evaluating the optimal input (x^*) and yield of the production process (y^*) (using Equation (2)), and the spot price (\tilde{p}) of the Good ψ along its probability distribution function (using Equation (8)).

An SREE also incorporates the clearing of the following three markets simultaneously: (i) a futures market for the output (with price f); (ii) a spot market for any remaining output (with random price \tilde{p}); and (iii) a market for the numeraire input (which serves as the producer's endowment). The last market clears as a consequence of Walras' Law (see Patinkin, 2008).

Key Results of the Simple Model

Theorem:

Hedging commodity price risk in a perfect and complete market (in a simple one period economy comprising of heterogeneous Producers, Consumers and Speculators) yields differential consumption smoothing costs along with the following results.

First, in the absence of any position limits, our model solution exhibits multiple Stationary Rational Expectations Equilibria, ranked in a pecking order of decreasing pareto-efficiency. The equilibria range from the completely unconstrained interior one (where agents have absolutely no market power) to corner ones (where one or more agent(s) have market power).

Second, excessive speculation in our framework is *foolhardy*. This is because it is not at all beneficial to the financially astute speculator, as it leads to expropriation of the economic surplus by either the producer or the consumer or both.

Third, restrictive position limits imposed on speculators impact on the freedom to contract of all, including the hedgers (i.e. the producers and consumers), because of the aggregate demand-supply relationship of futures. Limiting the speculators ability to contract reduces the volume of trade and thus the liquidity of these contracts. Position limits also impact on the social welfare of agents in the economy: they steer the economy from the more efficient equilibrium to the remaining less efficient equilibria in the order of increasing restrictiveness. Nonetheless, binding position limits have an inadvertent result: they do *not* reduce market power of economic agents but rather enhance it. This is attributed to the degeneration of the equilibria to corner solutions, where the non-satiation limits of agents increasing market power are reached.

Finally, normal backwardation (in the sense of Keynes, 1930) is still the norm in all these equilibria for strictly Normal or Inferior commodities.

Proof of Theorem: See the Appendix for full details.

Thus, our simple general equilibrium model yields intricate multiple equilibria ranked in the decreasing order of pareto-efficiency. This result stems from our non-linear framework and is therefore different from a linear “cash-and-carry”, where arbitrage yields a unique equilibrium devoid of risk aversion parameters (see Hull, 2006). In our setting, excessive speculation is not worthwhile for a financially astute speculator, as it is akin to a “winner's curse” (see Thaler, 1988). This result is quite important, as it illustrates the link between a setting involving risk aversion under heterogeneity of wealth and that of asymmetric information employed in demonstrating the winner's curse. This conclusion also affirms two empirical findings of Irwin and Sanders (2010). First, if the Speculators know that bidding very high is not worthwhile, they will bid to the extent that prices do not constitute a bubble. Second, in a dynamic environment, if the equilibria shuttle between limited ones, it will result in lower volatility. Finally, we contrast our findings with that of P&S. We illustrate that: (i) hedging demand is endogenous; (ii) binding position limits hinder the capacity of even hedgers to contract; (iii) an increase in restrictiveness of these limits leads to a deterioration of equilibria; and (iv) binding position limits in our model are superfluous, as our economy already has checks and balances to thwart the frivolous efforts of speculators bent on manipulating the futures market. This is because Speculators in our model cannot buy more futures contracts than the commodity available in the spot market at expiration. This therefore

avoids the well-known “corner” or “squeeze” where they cannot compel those agents who have sold to them and cannot deliver to buy back their contracts at a huge premium.²⁰ Position limits, nonetheless, are counter-productive as they aggravate futures price volatility, reduce liquidity, economic efficiency, while simultaneously increasing market power of Speculators (and other agents in the economy). We therefore conclude that position limits are detrimental and do not restrain excessive speculation and thus market manipulation.

V. EXTENSION OF THE SIMPLE MODEL TO STORABLE COMMODITIES

Our assumption of perishability of Good ψ (in Sections III and IV) helps make the model more tractable in a one period world. This presumption can be relaxed, by extending the analysis of Anderson and Danthine (1983) to include n_1 Storage (Inventory) Operators (I). This allows us to investigate a special case where hedgers have the capacity to speculate but are classified as “commercials” and not subject to position limits normally. For the purpose of convenience, we assume that each operator is endowed with e_1 units of numeraire good along with access to a storage facility containing T units of Good ψ worth (p_0T in terms of the numeraire good). These initial units in the inventory are assumed to be only for the sake of convenience and are to be replenished either in excess or same or reduced amount at $t = 1$. This is illustrated as $T(1+\rho)$, where the endogenously evaluated term $\rho > \frac{\delta}{(1-\delta)}$ [$< \frac{\delta}{(1-\delta)}$] represents a net increase [decrease] of inventory (after incorporating the rate of wastage, i.e., δ), while $\rho = \frac{\delta}{(1-\delta)}$ represents replenishing the inventory at the rate of its wastage (see Equation (15)).²¹ This optimal amount (T) of Good ψ in the facility constitutes an optimal storage policy of the agent.

²⁰ The above result is also in agreement with another empirical finding of Irwin and Sanders (2010), where they do not find evidence that index investors (i.e., investors in futures based Commodity Exchange Traded Products) “distort” futures and cash markets. This is because these investors “do not participate in the futures delivery process or the cash market where long-term equilibrium prices are discovered. Index investors are purely involved in a financial transaction using futures markets. They do not engage in the purchase or hoarding of the cash commodity and any causal link between their futures market activity and cash prices is unclear...Hence, to draw a parallel with the Hunt brothers' corner of the silver market is flawed” (Irwin and Sanders, 2010, p. 6).

²¹ We generally assume ρ to be a fraction indicating a gradual buildup of inventories when $\rho > \frac{\delta}{(1-\delta)}$ and depletion when $\rho < \frac{\delta}{(1-\delta)}$. In the last case, ρ is assumed to be in the closed interval $(-1, \frac{\delta}{(1-\delta)})$.

V.a. The Storage (Inventory) Operator (I):

The goal of each of the n_i Operators is to optimally select the amount (T) of Good ψ and to pre-sell (q_i) in the futures market (at a unit price f) in order to maximize their expected indirect utility of consumption. That is,

$$\begin{aligned} & \text{Max. } E_0 \{U_1(\tilde{c}_1)\} \\ & \text{(in } c_1, T, q_i) \end{aligned}$$

subject to the budget constraint

$$\tilde{c}_1 = e_1 + \tilde{p} [T(1 - \delta)] - R (p_0 T) + q_i (f - \tilde{p}) \quad (12)$$

where \tilde{c}_1 is the consumption of Operator at $t = 1$, δ is the exogenous rate of wastage of inventory (T), R exogenous opportunity cost of Operator's capital, while the remaining notations have the same meaning as stated earlier.

The budget constraint at $t = 1$ (Equation 12) illustrates consumption of Storage Operator utilizing the residual of endowment (net of the opportunity cost of carrying the inventory, i.e., $(e_1 - R (p_0 T))$, along with the proceeds of selling Good ψ (in terms of the numeraire good) via: (i) Futures Market (involving q_i units at a fixed price f) and (ii) Spot Market (involving storage net of wastage $(T(1 - \delta))$ at the prevailing stochastic price \tilde{p}).

The objective function of each of the Operators can be rewritten as:

$$\begin{aligned} & \text{Max. } E_0 \{U_1[e_1 + T (\tilde{p} (1 - \delta) - R p_0) + q_i (f - \tilde{p})]\} \\ & \text{(in } T, q_i) \end{aligned}$$

The First Order Necessary Conditions (FONCs or Euler Equations) are evaluated as follows:

- (i) At the margin, optimal storage satisfies the following:

$$\begin{aligned} E_0[U'_1(\tilde{p} (1 - \delta) - R p_0)] &= 0, \forall T^* \in (0, \tilde{y}^*) \\ E_0[U'_1(\tilde{p} (1 - \delta) - R p_0)] &< 0, \forall T^* = 0 \end{aligned} \quad (13)^{22}$$

The above equation denotes the optimal storage policy of the operator.

²² It should be noted that the condition $T \geq 0$ is termed as the Gustafson (1958) condition reinforcing the impossibility of carrying forward negative inventories. Furthermore, T is strictly less than \tilde{y}^* as a positive amount of $(\tilde{y}^* - T)$ is needed for our extended model to have a solution.

- (ii) At the margin, the Operator will sell optimally forward q_t units of Good ψ , which yield net benefits at least equal to zero. This implies that the Operator will participate in the futures market only when the optimal price of futures (f) is evaluated as follows:

$$\begin{aligned} f \geq \left\{ \frac{E_0(U_1'(\tilde{c}_t) \tilde{p})}{E_0(U_1'(\tilde{c}_t))} \right\} &= \left\{ \frac{E_0(U_1'(\tilde{c}_t))E_0(\tilde{p}) + \text{Cov}_0(U_1'(\tilde{c}_t), \tilde{p})}{E_0(U_1'(\tilde{c}_t))} \right\} \\ &= E_0(\tilde{p}) + \frac{\text{Cov}_0(U_1'(\tilde{c}_t), \tilde{p})}{E_0(U_1'(\tilde{c}_t))}, \forall q_t > 0 \end{aligned} \quad (14)$$

The above equation represents the *supply* side relationship of q_t units of storage pre-sold (at a price) f , where the equality [strict inequality] sign illustrates the respective cases where the operator has absolutely no power [or has the power] to expropriate economic surplus from the agent(s) in the economy.

Thus, a unique and constrained maximum of the Storage Operator's objective function requires that the following conditions are satisfied: firstly, the stochastic budget constraint (at $t = 1$), as illustrated by Equation (12); and secondly, the simplified FONCs (Euler Equations) as depicted by Equations (13) and (14). The second order conditions for a maximum are automatically satisfied due to the properties of a strictly concave and twice continuously differentiable objective function utility function with quasi-convex constraints (see Chiang, 1984).

V.b. The Binding Constraints on Agents in our Extended Economy:

- (i) For the real sector of the economy to be in equilibrium, the aggregate demand stemming from Consumers as well as Storage Operators (in terms of inventory replacement) must equal the optimal aggregate supply stemming from Producer and Storage Operator (net of wastage):

$$\begin{aligned} \text{That is, } n_c [D(\tilde{p}, e_c)] + n_t [T (1 + \rho)] &= n_p [g^*(x^*, \tilde{\xi})] + n_t [(1 - \delta) T] \\ \Rightarrow n_c [D(\tilde{p}, e_c)] &= n_p [\tilde{y}^*] - n_t [(\delta + \rho) T] \end{aligned} \quad (8')$$

- (ii) In a Stationary Rational Expectations Equilibrium (SREE), Consumers commit themselves to the minimum value of their exogenous demand function in the worst state

of the economy, i.e., $\text{Min.}[D(\tilde{p}, e_c)] = \frac{n_p}{n_c} \{\text{Min.}[\tilde{y}^*]\} - \frac{n_l}{n_c} \{(\delta + \rho) T\}$, using Equation (8').

$$\Rightarrow q_c \in (0, \frac{1}{n_c} [n_p (\text{Min}(\tilde{y}^*)) - n_l (\delta + \rho) T]] \quad (9')$$

Likewise, Producers refrain from entering into futures obligations (q_p) more than what they can deliver in the worst state of the economy, i.e., $\{\text{Min.}[\tilde{y}^*]\}$.

$$\begin{aligned} \Rightarrow \{\text{Min}[\tilde{y}^*]\} &\geq q_p > 0 \\ \Rightarrow q_p &\in (0, \text{Min}[\tilde{y}^*]) \end{aligned} \quad (10)$$

(iii) For the financial sector of the economy to be in equilibrium:

Futures contracts negotiated by the suppliers (Producers and Storage Operators) must equal that demanded by Consumers and Speculators.

$$\begin{aligned} \text{That is, } n_p q_p + n_l q_l &= n_c q_c + n_s q_s \\ \Rightarrow q_s &= \left[\frac{(n_p q_p + n_l q_l - n_c q_c)}{n_s} \right] \end{aligned} \quad (11')$$

(iv) For market manipulation, Operator's strategy would be to intentionally build up or deplete inventory. This would undermine both pricing and market liquidity according to Equation (8'):

$$\begin{aligned} (1+\rho)(1-\delta) &> 1 \text{ for inventory buildup.} \\ &= 1 \text{ for the normal case with replenishment of inventory to offset wastage.} \\ &< 1 \text{ for inventory depletion.} \\ \Rightarrow \rho &> \left[\frac{\delta}{1-\delta} \right] \text{ for inventory buildup.} \\ \rho &= \left[\frac{\delta}{1-\delta} \right] \text{ for the normal case with replenishment of inventory.} \\ \rho &< \left[\frac{\delta}{1-\delta} \right] \text{ for inventory depletion.} \end{aligned} \quad (15)$$

V.c. Key Result of the Extended Model:

Hedging commodity price risk in a perfect and complete capital market (in a one period economy composed of heterogeneous Producers, Consumers, Speculators and Storage Operators) again yields differential consumption smoothing costs and results qualitatively similar to that of our simple model of Sections III and IV. The case when the operator replenishes an amount equivalent to what was originally received (after incorporating for

wastage), i.e., $\rho = \frac{\delta}{1-\delta}$, constitutes the normal case, where inventory buildup exactly offsets wastage (see Equation (15)). However, the case where an Operator is building [depleting] the inventory (net after wastage), i.e., when $\rho > \frac{\delta}{1-\delta}$ [$< \frac{\delta}{1-\delta}$] potentially constitutes one where illegal price manipulation is feasible, as it impacts on pricing accuracy and market liquidity. This is because storage generally impacts on the distribution of spot prices, as demonstrated in Equation (8'), whilst the buildup or depletion of inventory impacts on its liquidity.²³ This affirms the assertions of Deaton and Laroque (1992) and Chambers and Bailey (1996). Nonetheless, the addition of storage still does not make it worthwhile to speculate excessively, as Equation (14) illustrates that it is tantamount to giving up economic surplus to rival agents in the economy. The special cases where $\rho > \frac{\delta}{1-\delta}$ [$< \frac{\delta}{1-\delta}$] would be strictly classified in Kyle and Vishwanathan's (2008) terminology as corner or squeeze ["reverse" corner or squeeze]. This would attract regulatory attention and possible imposition of position limits, even though the operator is classified as a "commercial" entity. If this were to take place, then in this case too position limits would be detrimental to the economic system.

VI. CONCLUDING REMARKS

This paper is based on the insight of Arrow (1970). It studies the excessive speculation by financially astute investors and the imposition of position limits to curb it. That is, wealth impacts on hedging (consumption smoothing) costs to produce equivalence between a framework of risk aversion and symmetric information with that of asymmetric information. We present a simple general equilibrium model under a setting of rational expectations and complete markets, incorporating competition between economic agents alongside some real/financial sector constraints. Our model can be construed as a "trade-based manipulation" one in the terminology of Kyle and Vishwanathan (2008). Our result illustrate that excessive speculation, with or without the intention to manipulate the futures markets, is not worthwhile for the speculator, as it serves to enrich other agents in the economy at the expense of the speculator. This result supplements that of Milgrom and Stokey (1982) and Tirole (1982) to the special case where agents' wealth bestows on them the capacity to impact on futures prices.

²³ Note, a special subcase of inventory depletion $\rho = -\delta \varepsilon (-1, \frac{\delta}{1-\delta})$, which does not impact on the distribution of spot prices (see Equation (8')).

The restraints placed on speculators, in the form of position limits, are transmitted to hedgers through the aggregate demand-supply condition of futures, thereby inhibiting their freedom and ultimately affecting the social welfare of all agents in the economy. This simultaneously reduces the endogenous hedging demand, volume of trade and thus the liquidity of these contracts. These binding constraints have an unintentional effect. That is, they lead to a degradation of the equilibria and augmenting market power of Speculator in addition to other agents. We therefore conclude that position limits are not helpful in curbing market manipulation. Instead of curtailing price swings, they could exacerbate them. The imposition of position limits may ultimately lead to “destructive conservation”, quite the opposite of Joseph Schumpeter's process of “creative destruction,” which is required for innovation and development.

If, as our results suggest, position limits cannot deter “rogue” trading, then the only feasible solution is to curtail moral hazard, which leads to excessive risk taking, as a crucial part of a broad based risk-management program, designed from the trading desk level to the global level as described below.^{24, 25}

First, the industry needs to invest in an electronic infrastructure, which speeds up the processing and administration of trades. Second, investment banks need to invest in surveillance technology that focuses on traders' gross positions (instead of net exposure). Top management should be held accountable for ensuring efficient control systems. An independent committee should monitor risk control. Fraud should be considered an operational risk and regulators should be kept posted on any breach (even those where no negative consequences are identified). Third, in case of hedge funds, it is more practical for regulators to control their risk exposure by monitoring the banks that lend to these institutions. These banks should also tighten credit standards on hedge funds with concentrated investment strategies, as opposed to those with a broad (i.e., a macro) based one. Fourth, a principles-based approach needs to be adopted, where regulators and those being regulated engage in a constant dialogue about risk and compliance. This system is different from a rules-based one, which relies on participants complying with a set of rules. The CFTC's approach encourages cooperation with

²⁴ Pignal (2009) attributes weakness in compliance system as a major factor in provoking “rogue” trading.

²⁵ It should be noted that some of the recommendations given below emanate from the well-known Corrigan Report drafted by the Counterparty Risk Management Policy Group III (2008).

those being regulated, backed by enforcement in cases of market abuses such as fraud, price manipulation etc. The dialogue needs to be translated into coordination between regulators and industry to reinforce practices for risk management and controls. Finally, the regime at the national level needs to be consolidated and harmonized with the international ones to deter regulatory arbitrage. Our last recommendation is consistent with the financial integration hypothesis of Colacito and Croce (2010) but under the watchful eyes of regulators to mitigate systemic risk, as espoused in Stiglitz (2010).

APPENDIX

Proof of Theorem: We prove our assertions in the following order.

Assertion 1 – Model Solution in the Absence of Position Limits and Excess Speculation:

Here the solutions are ranked in the decreasing order of pareto-efficiency, described as follows. The most efficient equilibrium constitutes the unique one (not subject to any binding constraints). The mid-ranked equilibria constitute those (subject to a single binding constraint). Finally, the lowest-ranked equilibria constitute the ones (subject to two binding constraints). The pareto-ranking of the equilibria stems from the fact that welfare of agents in an unconstrained optimization model is higher than that in a constrained one. Therefore, as more binding constraints are added to the model, the equilibria obtained decrease in pareto-efficiency, endowing market power (and thus economic surplus) to one or more agents. This inadvertent result follows from the definition of pareto-efficiency that: (i) binding constraints reduce the welfare of at least one agent without increasing that of the remaining; and (ii) constraints generally make it infeasible for agents to adjust their marginal utility, thereby leading to a degeneration of the equilibrium from an interior one (where futures pricing Equations (3), (5) and (7) hold as an equality) to corner ones (where market power is retained by one or two agents in the economy).

The Highest Ranked Equilibrium (PCS):

This is essentially the interior equilibrium, where the futures contracting of all hedgers are in the satiating region, i.e., in the semi-closed interval described by Equations (9) and (10). This equilibrium is evaluated by superimposing the demand-supply financial sector (i.e., futures) constraint (Equation 11) on the respective pricing functions of various agents derived in Sections III.a-c. Since the equilibrium in this case involves four endogenous variables (f , q_p , q_c , q_s), four independent Equations (3), (5), (7) and (11) are sufficient to yield a unique

solution. The uniqueness of our result stems from Chiang (1984), who demonstrates that maximization of a strictly concave and twice continuously differentiable objective function with quasi-convex constraints yields a negative definite bordered Hessian matrix. We thus consolidate Equations (3), (5) and (7) in the form described below:

$$f - E_0(\tilde{p}) = \frac{\text{Cov}_0(U_P'(\tilde{c}_P), \tilde{p})}{E_0(U_P'(\tilde{c}_P))} = \frac{\text{Cov}_0(U_C'(\tilde{c}_C), \tilde{p})}{E_0(U_C'(\tilde{c}_C))} = \frac{\text{Cov}_0(U_S'(\tilde{c}_S), \tilde{p})}{E_0(U_S'(\tilde{c}_S))}. \quad (16)$$

Here the marginal utility of each agent adjusts in such a way that no agent is able to extract any economic surplus from the other. Deviation of futures price from expected spot price is given in terms of a covariance term (of marginal utility of stochastic consumption with price risk) divided by expectation of marginal utility of consumption. The stochastic consumption parameter of all agents is impacted jointly by the yield and price risks, as illustrated in Equations (1), (4) and (6).

Non-Satiation of Futures Contracting of either Producer or Consumer:

This leads to the infeasibility of Equation (16), leading to the deterioration of equilibrium to either the mid-ranked or lower-ranked ones described below.

The Mid-Ranked Equilibria (CS or PS):

In general, if any one agent reaches the non-satiation region (i.e., in the right hand side of extreme end of the semi-closed interval), then its corresponding futures pricing condition changes to a strict inequality, endowing that agent with market power. This situation is observed in at most two equilibria, as described below. Here, the economic surplus is extricated by the agent whose futures pricing equation holds as a strict inequality. Since this subcase involves three endogenous variables (f , q_p or q_c , q_s), three independent Equations [two from (3), (5) or (7) and one from (11)] are sufficient to yield a unique solution.

To elaborate the above point further:

- (i) If the Producer reaches the non-satiation limit, then $q_p = \{\text{Min}[\tilde{y}^*]\}$.

$$\Rightarrow n_p \{\text{Min}[\tilde{y}^*]\} = n_c q_c + n_s q_s \text{ (using Equation (11))}$$

We thus solve for the endogenous variables (f , q_c , q_s) using the above conditions and the following equations for Equilibrium (CS).

Equilibrium (CS):

Here, the futures pricing is determined by both Consumers and Speculators, while the economic surplus is retained by the Producer. That is,

$$f - E_0(\tilde{p}) = \frac{\text{Cov}_0(U_c'(\tilde{c}_c), \tilde{p})}{E_0(U_c'(\tilde{c}_c))} = \frac{\text{Cov}_0(U_s'(\tilde{c}_s), \tilde{p})}{E_0(U_s'(\tilde{c}_s))}, \text{ and}$$

$$f - E_0(\tilde{p}) > \frac{\text{Cov}_0(U_p'(\tilde{c}_p), \tilde{p})}{E_0(U_p'(\tilde{c}_p))}. \quad (17a)$$

(ii) If the Consumer reaches the non-satiation limit, then $q_c = \frac{n_p}{n_c} \{\text{Min}[\tilde{y}^*]\}$.

$$\Rightarrow n_p q_p = n_p \{\text{Min}[\tilde{y}^*]\} + n_s q_s \text{ (using Equation (11))}$$

$$\Rightarrow n_p \{q_p - \{\text{Min}[\tilde{y}^*]\}\} = n_s q_s$$

$$\because q_p \text{ is restrained by Equation (10), i.e., } q_p \leq \{\text{Min}[\tilde{y}^*]\} \Rightarrow q_s \leq 0.$$

Here, we derive Equilibrium (**PS**) by solving for the endogenous variables (f , q_p , q_s), using the above conditions and the following equations.

Equilibrium (**PS**):

Here, the futures pricing is determined by both Producers and Speculators, while the economic surplus is retained by the Consumer. That is,

$$f - E_0(\tilde{p}) = \frac{\text{Cov}_0(U_p'(\tilde{c}_p), \tilde{p})}{E_0(U_p'(\tilde{c}_p))} = \frac{\text{Cov}_0(U_s'(\tilde{c}_s), \tilde{p})}{E_0(U_s'(\tilde{c}_s))}, \text{ and}$$

$$f - E_0(\tilde{p}) < \frac{\text{Cov}_0(U_c'(\tilde{c}_c), \tilde{p})}{E_0(U_c'(\tilde{c}_c))}. \quad (17b)$$

The Lower-Ranked Equilibria (**S**):

If the above mid-level equilibria **CS** or **PS** are infeasible, then we investigate the feasibility of one where the futures pricing function is determined by the Speculator alone. Here too, the economic surplus is extricated by the hedgers, whose futures pricing conditions hold as strict inequalities.

Equilibrium (**S**):

$$f - E_0(\tilde{p}) = \frac{\text{Cov}_0(U_s'(\tilde{c}_s), \tilde{p})}{E_0(U_s'(\tilde{c}_s))},$$

$$\begin{aligned}
f - E_0(\tilde{p}) &> \frac{\text{Cov}_0(U_p'(\tilde{c}_p), \tilde{p})}{E_0(U_p'(\tilde{c}_p))}, \text{ and} \\
f - E_0(\tilde{p}) &< \frac{\text{Cov}_0(U_c'(\tilde{c}_c), \tilde{p})}{E_0(U_c'(\tilde{c}_c))}.
\end{aligned} \tag{18}$$

Assertion 2 – Impact of Excessive Speculation (in the absence of Position Limits):

Here we assume increasing financial prowess of speculator, i.e., increasing value of initial endowment e_s . This leads to diminishing marginal utility of consumption of speculator, resulting in the speculator outbidding either one or both rivals in the futures market. This result ensues from studies, which document that wealthier economic agents are more risk tolerant and willing to outbid their rivals (see Schechter, 2007; and Guiso and Paiella, 2008). An alternative way is to perceive poorly endowed agents as more risk averse and therefore refraining from outbidding their wealthier rivals (see Rabin, 2000). The resulting equilibria are thus either the (i) mid-ranked ones, such as **CS** or **PS**; or the lower ranked one, such as **S**. In all cases, the economic surplus is extricated by agents such as Producer (in case of **CS**) or Consumer (in case of **PS**) or both Consumer and Producer (in case of **S**), as illustrated above in: (i) Equations (17a/ 17b); or (ii) Equation (18) respectively. Thus, excess speculation serves as a “winner's-curse”, as speculator does not reap any benefit from outbidding rivals (see again Thaler, 1988). This result thus extends that of Milgrom and Stokey (1982) and Tirole (1982) construed in a PE framework.

Assertion 3 – Impact of Binding Position Limits:

Restrictive position limits imposed on speculator constrain the financial contracting ability of Producers and/ or Consumers through the aggregate demand-supply condition of futures (i.e., Equation (11)) and operational capacity of hedgers (i.e., Equations (10) and (9)). Thus, restrictions on Speculator simultaneously: (i) reduce the ability of either Producer and/ or Consumer; along with (ii) increasing the non-satiation levels of Speculator in addition to Producer and/ or Consumer. This leads to a decrease in pareto-efficiency, conveying market power (and ensuing economic surplus) to the Speculator, in addition to one or more agents in the economy, as illustrated in Equilibria **P** and **C** given below.

Equilibrium (**P**):

$$f - E_0(\tilde{p}) = \frac{\text{Cov}_0(U_p'(\tilde{c}_p), \tilde{p})}{E_0(U_p'(\tilde{c}_p))},$$

$$\begin{aligned}
f - E_0(\tilde{p}) &< \frac{\text{Cov}_0(U_c'(\tilde{c}_c), \tilde{p})}{E_0(U_c'(\tilde{c}_c))}, \text{ and} \\
f - E_0(\tilde{p}) &< \frac{\text{Cov}_0(U_s'(\tilde{c}_s), \tilde{p})}{E_0(U_s'(\tilde{c}_s))}.
\end{aligned} \tag{19a}$$

Equilibrium (C):

$$\begin{aligned}
f - E_0(\tilde{p}) &= \frac{\text{Cov}_0(U_c'(\tilde{c}_c), \tilde{p})}{E_0(U_c'(\tilde{c}_c))}, \\
f - E_0(\tilde{p}) &> \frac{\text{Cov}_0(U_p'(\tilde{c}_p), \tilde{p})}{E_0(U_p'(\tilde{c}_p))}, \text{ and} \\
f - E_0(\tilde{p}) &< \frac{\text{Cov}_0(U_s'(\tilde{c}_s), \tilde{p})}{E_0(U_s'(\tilde{c}_s))}.
\end{aligned} \tag{19b}$$

The above unintentional results follow from the definition of pareto-efficiency that: (i) binding constraints reduce the welfare of at least one agent without increasing that of the remaining; and (ii) constraints generally make it infeasible for agents to adjust their marginal utility, thereby leading to a deterioration of equilibrium to corner ones where market power of Speculator (and/ or one or more agent) is enhanced. Thus, position limits are back-firing, as they boost market power instead of reducing it.

Finally, we illustrate the special subcases (of the above equilibria contrary to the results of P&S), where the positions limit on Speculator is so restrictive that it leads to binding constraints on both the Producers and Consumers. That is, $q_p = \{\text{Min}[\tilde{y}^*]\}$ and $q_c = \frac{n_p}{n_c} \{\text{Min}[\tilde{y}^*]\} \Rightarrow q_s = 0$ (Using Equation (11)). Here again, we realize at most two more equilibria (**P'** or **C'**) by using the above conditions and the respective pricing functions of any one hedger (while that of the remaining holds as strict inequality), as described below. It should be noted that if the hedgers are equally risk averse, then these special subcases constitute a violation of Keynes (1930). This is because Keynes postulated that when supply and demand (of futures by equally risk averse hedgers) offset each other, then there is no need for discount or premium. Equations (19c-d), however, depict situations contrary to Keynes (1930), as the Covariance term illustrates Normal Backwardation.

Equilibrium **P'**:

$$\begin{aligned}
f - E_0(\tilde{p}) &= \frac{\text{Cov}_0(U_P'(\tilde{c}_P), \tilde{p})}{E_0(U_P'(\tilde{c}_P))}, \text{ and} \\
f - E_0(\tilde{p}) &< \frac{\text{Cov}_0(U_C'(\tilde{c}_C), \tilde{p})}{E_0(U_C'(\tilde{c}_C))}. \tag{19c}
\end{aligned}$$

Equilibrium C':

$$\begin{aligned}
f - E_0(\tilde{p}) &= \frac{\text{Cov}_0(U_C'(\tilde{c}_C), \tilde{p})}{E_0(U_C'(\tilde{c}_C))}, \text{ and} \\
f - E_0(\tilde{p}) &> \frac{\text{Cov}_0(U_P'(\tilde{c}_P), \tilde{p})}{E_0(U_P'(\tilde{c}_P))}. \tag{19d}
\end{aligned}$$

Assertion 4 – Confirmation of Normal Backwardation:

Our general results hold true even when normal backwardation (in the sense of Keynes, 1930) is the norm. This is because the sign of the fractional term on the right hand side of the pricing condition with the equality sign (representing the deviation of futures from the expected spot price) in Equations (16), (17a-b), (18), and (19a-d) is determined solely by the covariance term in the numerator. It is negative [positive] for strictly normal [inferior] Good ψ . This is attributed to the fact that futures contracting involves a trade-off between risk and return. When the covariance between Producer's yield and commodity spot price risks is highly positive [negative] for strictly normal [inferior] Good ψ , hedgers (Producers-Consumers) decrease [increase] their risk by committing to a futures price at a discount [premium] to expected spot, in accordance with the insurance perspective of futures, as articulated in Anderson and Danthine (1983) and Britto (1984).

Q.E.D.

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TABLE 1

Position Limit and Reportable Level Table of Commodity Futures Traded in the CBOT

Contract Name	Scale-Down Spot Month	Spot Month ^a	Single Month ^b	All Months Combined ^c	Reportable Futures level
AGRICULTURAL					
Corn & mini-sized Corn		600 (aggregate see # 9)	26,000 (aggregate, see # 1, 9)	42,000 (aggregate, see # 1, 3, 9)	250 (individual, see # 10)
Soybeans & mini-sized Soybeans		600 (aggregate see # 9)	8,600 (aggregate see 1, 9)	13,300 (aggregate see # 1, 4, 9)	150 (individual, see # 10)
South American Soybeans	(see # 11)	600	3,500 (see # 1)	5,500 (see # 1)	25
Wheat and mini-sized Wheat	(see # 8)	600 (aggregate see # 9)	11,100 (aggregate see # 1, 9)	14,500 (aggregate see # 1, 7, 9)	150 (individual, see # 10)
Oats		600	1,400 (see # 1)	2000 (see # 1, 6)	60
Rough Rice	200/250 (see # 5)	600	1,000	1,000 (see # 2)	50
Soybean Oil		540	6,600 (see # 1, 7)	8,600 (see 1, 7)	200
Soybean Meal		720	5,500 (see # 1, 7)	7,100 (see # 1, 7)	200
Soybean Crush Options			1,000 (see #1)	1,000	
Ethanol		200	1,000	1,000	25
METALS					
5,000 oz. Silver		1,500	6,000	6,000	150
100 oz. Gold		3,000	6,000	6,000	200
Mini-sized Silver		1,500	1,500	3,000	750
Mini-sized Gold		4,000	4,000	6,000	600

- a Net long or short effective at the close of trading two business days prior to the first trading day of the delivery month.
- b Futures-equivalent position limit net long or net short in any one month other than the spot month. Net equivalent futures long or short in all months and strike prices combined.
- c Futures-equivalent position limit net long or net short in all months and strike prices combined.

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- #1 Additional futures contracts may be held outside of the spot month as part of futures/futures spreads within a crop year provided that the total of such positions, when combined with outright positions, do not exceed the all months combined limit. In addition, a person may own or control additional options in excess of the futures-equivalent limits provided that those option contracts in excess of the futures-equivalent limits are part of an eligible option/futures spread.
- #2 No more than 1,000 futures-equivalent contracts net on the same side of the market are allowed in a single month in all strike prices combined.
- #3 No more than 26,000 futures-equivalent contracts net on the same side of the market are allowed in a single month in all strike prices combined.
- #4 No more than 8,600 futures-equivalent contracts net on the same side of the market are allowed in a single month in all strike prices combined.

- #5 In the last five trading days of the expiring futures month, the speculative position limit for the July futures month will be 200 contracts and for the September futures month the limit will be 250 contracts.
- #6 No more than 1,400 futures-equivalent contracts net on the same side of the market are allowed in a single month in all strike prices combined.
- #7 No more than 11,100 futures-equivalent contracts net on the same side of the market are allowed in a single month in all strike prices combined.
- #8 In the last five trading days of the expiring futures month in May, the speculative position limit will be 600 contracts if deliverable supplies are at or above 2,400 contracts, 500 contracts if deliverable supplies are between 2,000 and 2,399 contracts, 400 contracts if deliverable supplies are between 1,600 and 1,999 contracts, 300 contracts if deliverable supplies are between 1,200 and 1,599 contracts, and 220 contracts if deliverable supplies are below 1,200 contracts. Deliverable supplies will be determined from the CBOT's Stocks of Grain report on the Friday preceding the first notice day for the May contract month. For the purposes of this Appendix, one mini-sized Wheat contract shall be deemed to be equivalent to one fifth of a corresponding Wheat contract.
- #9 The net long or net short positions in Corn, Soybeans, or Wheat contracts may not exceed their respective position limits. The net long or net short positions in mini-sized Corn, mini-sized Soybeans, or mini-sized Wheat contracts may not exceed their respective position limits. The aggregate net long or net short positions in Corn and mini-sized Corn, Soybeans and mini-sized Soybeans, or Wheat and mini-sized Wheat contracts may not exceed their respective position limits. For the purposes of this Appendix, one mini-sized Corn, one mini-sized Soybean, or one mini-sized Wheat contract shall be deemed to be equivalent to one-fifth of a corresponding Corn, Soybeans, or Wheat contract.
- #10 The reporting level for the primary contract is separate from the reporting level for the mini-sized contract. Positions in any one month at or above the contract level indicated trigger reportable status. For a person in reportable status, all positions in any month of that contract must be reported. For the purposes of this Appendix, positions are on a contract basis.
- #11 In the last five trading days of the expiring futures month, the speculative position limit for the November futures month will be 180 contracts and for the January futures month the speculative position limit will be 100 contracts.

Sources: (1) www.cmegroup.com/files/CBOTChapter5_Interpretationclean.pdf;
(2) [www.cftc.gov/lawandregulation/federalregister/proposed rules/2007/e7-22681.html](http://www.cftc.gov/lawandregulation/federalregister/proposed%20rules/2007/e7-22681.html)